



INSTITUTE FOR DEFENSE ANALYSES

## **Forces Mobilization Model (FORCEMOB): Unclassified Training Tutorial**

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## Executive Summary

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The Forces Mobilization Model (FORCEMOB) is a modeling program used in the Risk Assessment and Mitigation Framework for Strategic Materials (RAMF-SM) in support of the Defense Logistics Agency (DLA). FORCEMOB estimates U.S. demands for goods and services during a national emergency scenario comprising economic and military conflicts. It calculates the economic demands (across 360 economic sectors) needed to support essential civilian, military, and emergency investment activities for each year of the scenario. Essential civilian demand refers to the civilian economy after accounting for possible homeland damage and exclusion of non-essential demands. Military demand encompasses both base military needs (Future Years Defense Program spending) and conflict military needs (the “extra” regeneration of forces lost in the conflict). Emergency investment is used to expand production in industries if necessary, and is automatically computed by an algorithm. These three categories of demand all require industrial output: for example, how much production from the rubber, electronics, and steel sectors are required to produce \$1B of automobiles? To regenerate 30 tanks lost in combat? To open a new factory? FORCEMOB uses data on future peacetime economic demand and expected conflict-related factors to estimate total economic production requirements. These estimates are used later in RAMF-SM to calculate demand for strategic and critical materials and identify potential shortfalls, and eventually, to determine requirements for the National Defense Stockpile (NDS).

### **A. FORCEMOB Model Calculations**

1. Computes a time-phased schedule of weapon requirements associated with a conflict
2. Translates these weapons demands into time-phased demands on industry
3. Adds in civilian and base military demand on industry
4. Determines industry supply capacity (domestic production plus imports minus exports)
5. Compares demand against supply and determines if any shortfalls in industrial output occur
6. Models the use of emergency investment to redress shortfalls; computes investment demand

**Table 1. FORCEMOB Input Files**

<b>Name of Input File</b>	<b>File</b>	<b>Use</b>
Control Inputs File	*.in	Lists directories and input files to use
Run File	*.inf	Lists what Control Inputs file to use
Element File	element.db	Lists economic sectors and maps MEIs to METs
Major End Item Requirements	*.mei	Lists weapons and quantities to be regenerated
Production Process Matrix	*.ppm	Industrial output required to produce weapons
PPM Lead Times	*.ppl	Time (months) needed to produce weapons
Cost Data	*.cst	Per unit cost of weapons
Major End Item Inventories	*.min	Null file
Base Military Requirements	*.mil	Economic output required for base (FYDP) military
Civilian Requirements	*.civ	Economic output required for civilian economy
Supply File	*.sup	Domestic production and imports/exports
Import-Export Factors	*.fie	Changes in imports/exports due to war conditions
Investment Distribution	*.idr	Demand placed on industrial sectors by investment
Investment Sector Mapping	*.ism	Maps sectors to investment distribution patterns
Investment Lead Times	*.ilt	Time needed to complete investment (by sector)
Q/K Ratios & EOC Fractions	*.qkf	Amount of output that could be produced in each sector per month per unit of capital, and per-sector plant capacity utilization fractions

# Contents

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Appendix A Abbreviations .....	A-1
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## **Forces Mobilization Model (FORCEMOB): Unclassified Training Tutorial**

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This brief was prepared for the Defense Logistics Agency (DLA). It was presented to DLA representatives in Spring 2015.

# **Forces Mobilization Model (FORCEMOB): Unclassified Training Tutorial**

2 April 2015

James S. Thomason, Project Leader  
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Thomas J. Wallace

This brief was prepared for the Defense Logistics Agency (DLA). It was presented to DLA representatives in Spring 2015.

## **IDA** | Introduction

- The Forces Mobilization Model (FORCEMOB) is a tool for estimating U.S. economic demand for goods, services, imports, and exports during a national emergency
- The *output* of FORCEMOB is used as *input* for other models that calculate demand for strategic and critical materials (S&CMs) and estimate possible supply shortfalls
- This document is an unclassified tutorial designed to rapidly guide a new user towards practical operation of FORCEMOB
  - Disclaimer: this document is not an exhaustive listing of FORCEMOB features and should not be treated as an authoritative source. IDA has produced detailed technical documentation of FORCEMOB (IDA Paper P-2953) if exact understanding of a particular point is required.

This brief is intended to rapidly guide a new user towards practical operation of FORCEMOB. It is important to understand that this brief shows the most common method of using FORCEMOB, but does not detail full FORCEMOB capabilities.

## **IDA** | Overview

- This briefing is divided into four thematic sections:
  1. **FORCEMOB in Context**  
*What question is FORCEMOB trying to answer? For what purpose?*
  2. **Conceptual Overview**  
*What is the “thousand-foot” view of FORCEMOB’s modeling logic?*
  3. **Practical Operation**  
*How should a user wrangle FORCEMOB input files to get the correct output?*
  4. **Sample Problems**  
*Simple practice problems allowing a new user to test their ability to operate FORCEMOB*
- It is designed to be used in conjunction with a training version of FORCEMOB available on CD from IDA Control and Distribution

The “training” version of FORCEMOB differs from the production version only in the data used. Because many FORCEMOB input files are classified, unclassified “dummy” data was created. In all other respects, however, the version of FORCEMOB provided with this briefing is identical to the production version.

# **FORCEMOB In Context**

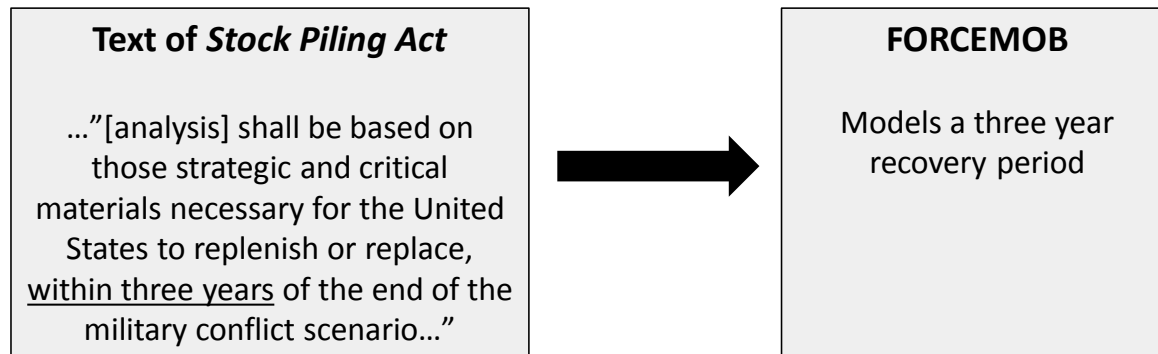


## **IDA | FORCEMOB History**

- FORCEMOB was originally developed at IDA in the late 1980s, and has supported every NDS Requirements Report (NDS-RR) thereafter
  - NDS-RR is a legally mandated, SECDEF-signed report to Congress that recommends materials for inclusion in the NDS program and proposes mitigation strategies for dealing with possible shortfalls
  
- IDA has continued to modify FORCEMOB to reflect changes in sponsor needs and the strategic environment, but much of the original methodology remains
  - For example, FORCEMOB was conceived in an era dominated by “big wars,” but has a sufficiently flexible framework to incorporate (for example) homeland damage events

## **IDA | FORCEMOB and Outside Influences**

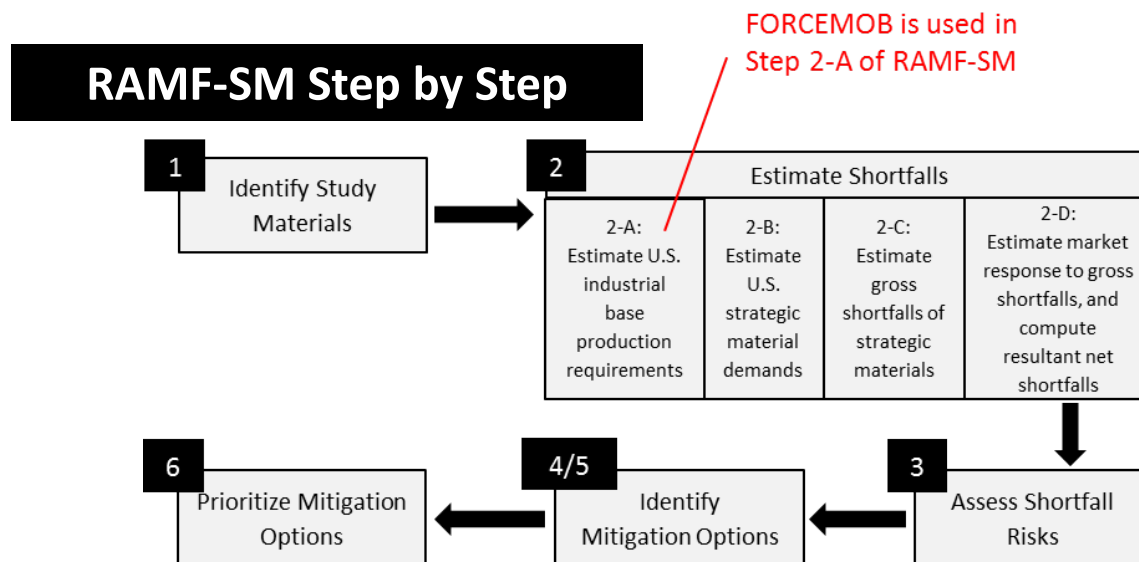
- Although IDA developed the FORCEMOB model, many data inputs are received from other organizations
  - For example, macroeconomic forecasts from the President's Council of Economic Advisors (CEA), casualty estimates from OSD-CAPE, etc.
- FORCEMOB is designed to satisfy NDS-RR legal requirements specified in the *Strategic and Critical Materials Stock Piling Act*



A full list of data inputs is available in D-5432, “An Overview of Step 2 of the Risk Assessment and Mitigation Framework for Strategic Materials (RAMF-SM).”

## IDA | FORCEMOB In Context

- FORCEMOB is used in Step 2-A of RAMF-SM to estimate U.S. economic production during a national emergency scenario

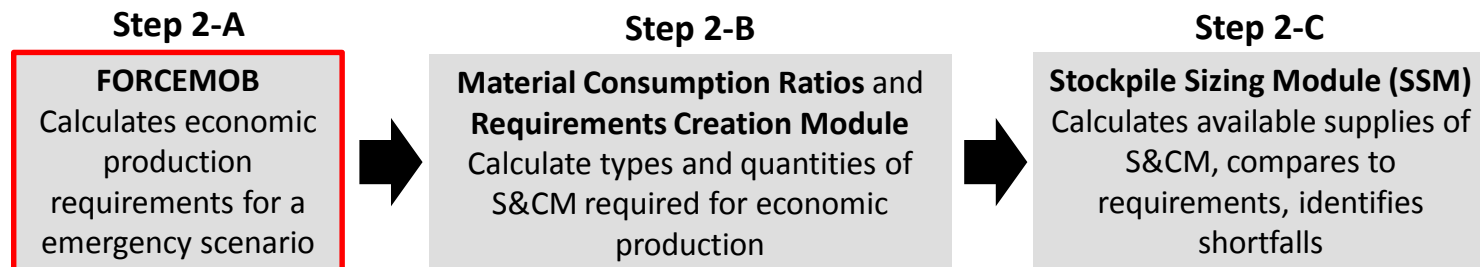


For a full guide to Step 2 of RAMF-SM, see IDA Document D-5432.

## **IDA | FORCEMOB Use**

- FORCEMOB's economic production estimates are used as input for other models in Step 2, with the ultimate goal being identification of potential material shortfalls

### **FORCEMOB's Relationship to Subsequent Models**



*Note: IDA has produced formal documentation and unclassified training tutorials for many of these subsequent models*

IDA documentation of RAMF-SM includes:

The aforementioned IDA Document D-5432, “An Overview of Step 2 of the Risk Assessment and Mitigation Framework for Strategic Materials (RAMF-SM)”

IDA Paper P-2953, “Documentation of the Forces Mobilization Model (FORCEMOB) Versions 3.1 and 3.2”

IDA Document D-5270, “Generic Unclassified Stockpile Sizing Module (SSM) Training and Testing for the National Defense Stockpile (NDS) 2015”

IDA Document D-5364, “Weapon-Specific Strategic Material Estimation Process (WSSMEP)”

In addition, each National Defense Stockpile Requirements Report (NDS-RR) typically includes detailed description of assumptions, methodologies, and data. See IDA Paper P-5190, “Analyses for the 2015 National Defense Stockpile Requirements Report to Congress on Strategic and Critical Materials.”

# **FORCEMOB Conceptual Overview**



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## **IDA | Measuring Economic Production**

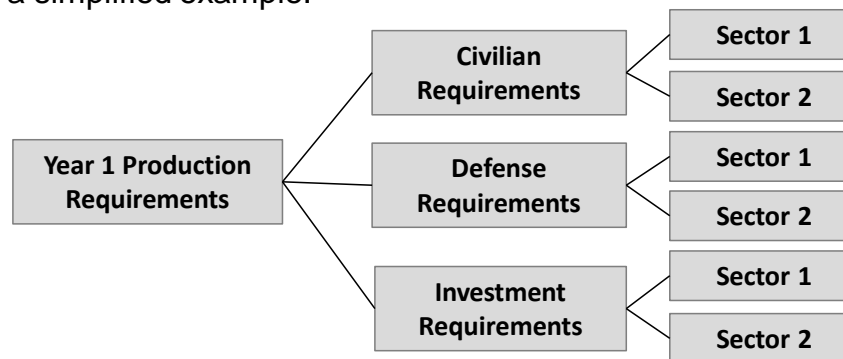
- FORCEMOB is a tool for estimating US economic demand during a national emergency
- How exactly does one measure “economic demand”?
- FORCEMOB relies on an *input-output* model of the economy: that is, how much input from other economic sectors is demanded to produce a fixed amount of output in a particular sector
  - For a simplified example, how much input from the steel, electronics, and rubber sectors is demanded to produce \$1B of output in the automobile sector?
- In FORCEMOB, the economy is divided into 360 industrial sectors
  - Sector definitions come from the Interindustry Forecasting Project at the University of Maryland (INFORUM)

Input-output (I/O) analysis represents the interdependencies between different branches of a national economy or different regional economies. I/O analysis was developed by Nobel Prize-winning economist Wassily Leontieff.

The Interindustry Forecasting Project at the University of Maryland (INFORUM) operates several structural economic models of the United States. A wide variety of U.S. government organizations, including the Bureau of Economic Analysis (BEA), use INFORUM's Long-term Interindustry Forecasting Tool (LIFT) and Interindustry Large-scale Integrated And Dynamic model (ILIAD) to conduct economic analysis.

## **IDA** | Tiers of Demand

- FORCEMOB also categorizes by *tiers of demand*
  - Essential Civilian
  - Defense
    - Includes both baseline peacetime Future Years Defense Program (FYDP) spending, and emergency regeneration of military forces lost in the conflict
  - Emergency Investment
    - Expansion of industrial capacity (capital investment) to meet extraordinary demands of war
- FORCEMOB estimates total economic production requirements by aggregating each slice of the economy
  - For a simplified example:



A high-level interagency working group determines what portion of the civilian economy the government is likely to classify as “essential.” This is covered in more detail in IDA Document D-5432.

## **IDA | Basic Scenario Assumptions**

- U.S. enters a military conflict placing extraordinary demands on the economy
- Invocation of the Defense Production Act, government consideration focused on essential civil economy
- Attrited or expended forces must be regenerated within three years of the end of the military conflict

Basic scenario assumptions are either specified in the language of the Stock Piling Act, or determined by the sponsor and transmitted to IDA.

## **IDA | Calculations**

- Once run, FORCEMOB conducts the following steps:
  1. Computes a time-phased schedule of weapon requirements associated with a conflict
  2. Translates these weapons demands into time-phased demands on industry
  3. Adds in civilian and base military demand on industry
  4. Determines industry supply capacity (domestic production plus imports)
  5. Compares industry demand against supply and determines if any shortfalls occur
  6. Models the use of emergency investment to redress shortfalls and compute emergency investment demand
- This section will give a high level overview of how FORCEMOB performs each step, with detailed explanations of files and operations in the next section



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## **IDA | Conflict Weapon Requirements**

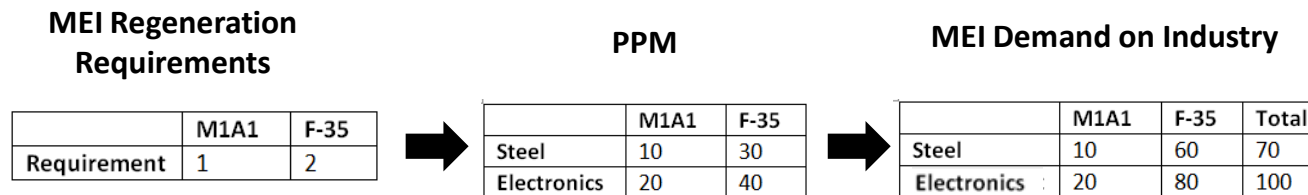
- Defense Planning Scenarios (DPS) produced by OSD-Policy provide the location & timeline of the conflict(s)
- OSD-CAPE provides casualty estimates of U.S. weapons systems – indexed as Major End Items (MEI) – attrited or expended in these conflicts
- Typically assume conflict lasts about one year, and that all lost MEIs must be regenerated by the end of the third year after the conflict

Defense Planning Scenarios and casualty estimates are classified.

## **IDA | Conflict Military Demand on Industrial Base**

- Production Process Matrix (PPM) defines demand placed by every weapon (MEI) on each of 360 economic sectors
  - Based on input-output analysis, and accounts for all facets of production (e.g. tool and die), not just the weapon itself
  - Computed by IDA using Defense Translator vectors from OSD-CAPE
- Combining MEI quantities and PPM entries yields the total economic production required for MEI regeneration

### **Simplified Example of FORCEMOB Calculations**



The example on this slide is simplified. In reality, Major End Item (MEI) regeneration requirements are expressed not in count terms (e.g., two tanks), but in dollar terms (e.g., \$100M of tanks). The Production Process Matrix (PPM) also is expressed in terms of some fixed dollar amount of output. Therefore, FORCEMOB conducts a number of cost and unit conversion calculations that are not shown in the simplified graphic. The essential logic, however, is the same: the production of weapons places demand on industrial sectors.

## **IDA | Civilian and Base Military Demands**

- Also must take baseline peacetime military demand into account
  - Baseline = production required to support all defense needs *besides* regeneration of forces (i.e., normal FYDP spending)
- Civilian economy demands production, even after accounting for austerity and possible homeland damage
  - The term “austerity” requires careful definition. It is used to refer to the possibility that the government may choose to only guarantee civilian economic demand that is deemed essential by a high-level interagency group, and does *not* refer to the imposition of restrictive measures on the civilian economy.
  - If the emergency scenario assumes a homeland attack, reconstruction is included in the civilian and base defense estimates
- Civilian and baseline military demand are calculated using macroeconomic modeling tools, and then input into FORCEMOB
  - INFORUM models (ILIAD and LIFT) are used

## **IDA | Industrial Supply Capacity**

- FORCEMOB models emergency investment to expand production capability in sectors not able to meet demand
- First, FORCEMOB identifies per-industry supply capacity
  - Industrial supply capacity = domestic production + imports – exports
  - Imports decremented to account for war conditions (e.g. shipping losses)
  - Exports decremented per policy guidance
- Then, FORCEMOB compares industrial supply to demand, identifies shortfalls, and allocates emergency investment
- Expansion of industrial capacity places demand on industrial base
  - For example, how much output from the construction and electronics sectors is required to build a new steel factory?

## **IDA | Accounting for Time**

- All of the described steps have a temporal dimension that is represented in FORCEMOB calculations
  - Different MEI are regenerated at different speeds
  - Different types of industrial expansion are achieved at different rates
  - Civilian economy may perform differently in different years
- FORCEMOB calculates economic requirements by year, sector, and tier



## **IDA | FORCEMOB Output**

- After performing calculations, FORCEMOB aggregates results and outputs result reports
- The most important reports are those that contain industrial production requirements (by year/tier/sector) for the U.S. during the scenario
- They are used later in Step 2 of RAMF-SM to compute S&CM requirements

# **FORCEMOB Practical Operation**

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## **IDA | Overview**

- FORCEMOB consists of a single executable program (written in FORTRAN) and many input files
- Running the executable causes it to gather data from the input files, perform operations, and output results
  - Once the .exe begins to run, there is no “human in the loop”; this demands careful attention to input files
- This section examines each input file and how to successfully run FORCEMOB using them
- The CD associated with this briefing contains all needed files and should be used in conjunction with this briefing

IDA is exploring recoding FORCEMOB from FORTRAN into C or C++.

## **IDA | General Notes on Input Files**

- FORCEMOB input files are fixed-width or space-delimited text
  - They have uncommon file extensions that denote their use (.mil , .civ, and so on), but can be opened in Notepad or Excel
- Some FORCEMOB input files are classified
  - Production versions of the below files are classified, but the versions provided with this briefing exclusively use “dummy” (i.e. fabricated) data

### **File**

Case File

MEI Requirements

MEI Inventories

Cost Data

Import/Export Factors

### **Why Classified?**

Lists start date of the modeled conflict

Lists U.S. weapons attrited & expended in the modeled conflict

Lists world-wide stocks of U.S. weapons systems

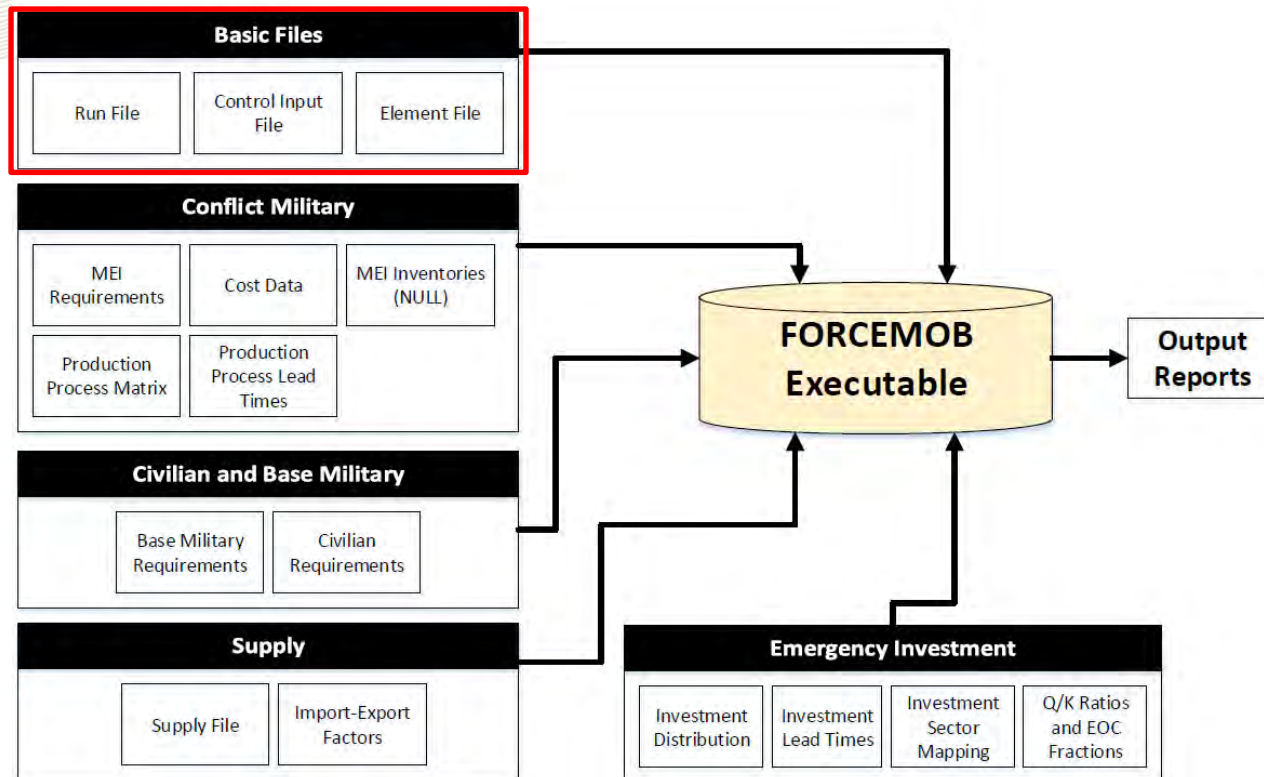
Lists dollar costs of sensitive U.S. weapons systems

Incorporates IC forecasts of foreign behavior during conflict

## **IDA | General Notes on Input Files**

- The novice user is encouraged to focus on learning to run FORCEMOB with pre-existing input files and to interpret results, not the creation or modification of input files
- Why?
  - The preparation of FORCEMOB input files requires complex modeling and preprocessing and is labor-intensive (weeks of staff time)
  - FORCEMOB input files have strict formatting guidelines: a single misplaced character or missing delimiter (out of thousands of lines of code) can cause the program to run incorrectly
  - The version of FORCEMOB provided with this briefing runs from CD with no configuration required; if the user modifies any portion of it, all bets are off

## IDA | Basic and Control Input Files





## **IDA | Control Inputs File**

- The **Control Inputs File** (recognizable by its **.in** file extension) can be considered the 'master file' for a FORCEMOB run
- The Control Inputs file allows the user to adjust almost every facet of FORCEMOB
  - Start and end dates of simulation period
  - Start of conflict
  - What directories and data input files to use
  - What computational methods to use (not covered in this briefing)
  - What output reports to write
- The following slide shows some of the most important aspects of the Control Inputs file

## IDA | Control Inputs File

```
sample.in - Notepad
File Edit Format View Help
'FILE SAMPLE.IN'
'TITLE' 'SAMPLE.IN'
'CODE SECTION' 0
'FILE OVERWRITE OK' 1
'DATA DIRECTORY' 'D:\FORCEMOB\'
'OUTPUT FILE DIRECTORY' 'D:\FORCEMOB\output\'
'SIM START' 1 2015
'SIM END' 12 2018
'CONFLICT START' 1 2015
'MEI INVENTORY FILE' 2 'meiinv'
'COST FILE' 3 'cost'
'PROD PROCESS LEAD TIMES' 4 'prodlead'
'PROD PROCESS MATRIX' 5 'prodpro'
'BASE MIL REQ' 6 'basemil'
'CIVILIAN REQ' 8 'civ'
'QK AND EOC' 9 'qkeoc'
'SUPPLY SIDE DATA' 10 'supply'
'INVESTMENT DISTRIBUTION' 11 'invdist'
'INVESTMENT LEAD TIMES' 12 'invlead'
'INVESTMENT SECTOR MAPPING' 13 'invmap'
'END OF DATA FILES MARK' 99 'xxxxxx'
'OPTIONAL FILES' 1
'MEI REQUIREMENTS FILE' 4 'meireq'
'SPECIAL CIVILIAN FACTOR?' 0
'SPECIAL BASE MILITARY FACTOR?' 0
'LEAD TIME FACTORS' 100 1 999
'THEATER DATA - PLAY ONE DUMMY THEATER'
'THEATER 1' 1 'Y' 1 2015 1 0 100.0
'FORM OF MEI REQ FILE' 2
'PERCENT OF MEI REQ' 100.
'INVESTMENT DATA'
'EOC EXPANSION' 100
'RAMP-UP PERIOD' 6
'DO INVESTMENT' 0
'PERLED' 100
'ICOLD' 1
'ICONV' 100
'MAXITER' 500
'MCR-BASED CALC' 5 'sample'
'ALT METHOD CALC' 15 'sample'
'END OF OUTPUT REPORTS' 99 'xxxxxx'
```

Directories for data and output reports

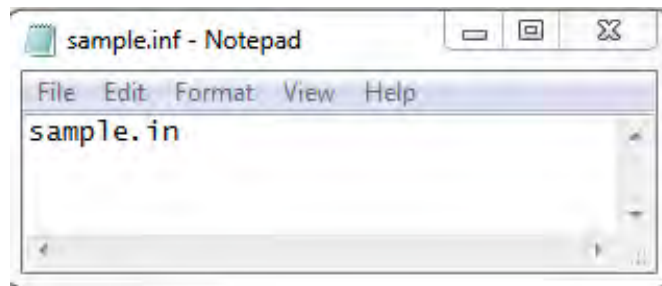
Month & year of sim start & end dates,  
and conflict start date

Input files to use

Output reports to write

## IDA | Run File

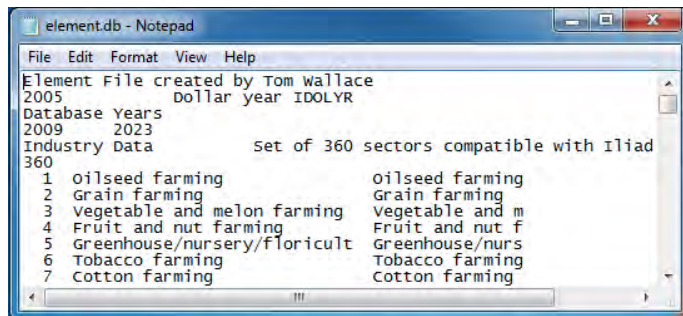
- The **Run File** (.inf format) lists the Control Inputs file to be used
- As implied by its name, the Run File plays a key role in running FORCEMOB – it provides a link between the computer and the data by ‘telling’ FORCEMOB to use a particular Control Inputs file (which itself ‘tells’ FORCEMOB what data files, directories, etc. to use)
- Multiple Control Inputs file can be run at once (“batch processing”), but in this example only one file is being run



## IDA | Element File

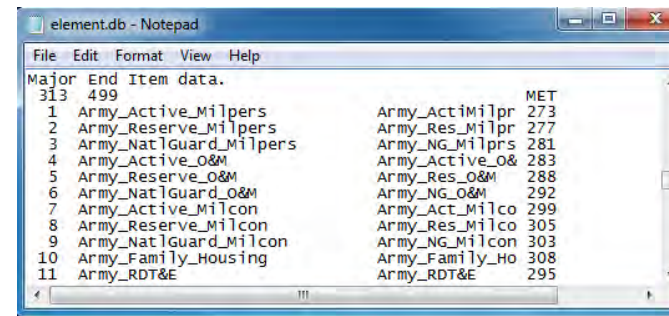
- The **Element File** (always named **element.db**) defines the industry sectors and weapons to analyze, the year in which constant dollars should be measured, and the range of years for which data exists (which often is larger than the simulation period)
- Other input files reference the Element File to ensure they are using the correct sectors, weapons, dollar year, and data range

ILIAD sectors



```
File Edit Format View Help
Element File created by Tom Wallace
2005 Dollar year IDOLYR
Database Years
2009 2023
Industry Data Set of 360 sectors compatible with Iliad
360
1 oilseed farming oilseed farming
2 Grain farming Grain farming
3 Vegetable and melon farming Vegetable and m
4 Fruit and nut farming Fruit and nut f
5 Greenhouse/nursery/floricult Greenhouse/nurs
6 Tobacco farming Tobacco farming
7 Cotton farming Cotton farming
```

MEI to MET mapping

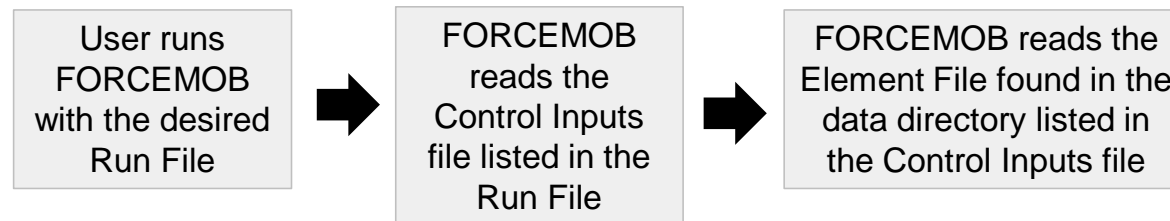


```
File Edit Format View Help
Major End Item data.
313 499
1 Army_Active_Milpers Army_ActiMilpr 273
2 Army_Reserve_Milpers Army_Res_Milpr 277
3 Army_NatlGuard_Milpers Army_NG_Milprs 281
4 Army_Active_O&M Army_Active_O& 283
5 Army_Reserve_O&M Army_Res_O&M 288
6 Army_NatlGuard_O&M Army_NG_O&M 292
7 Army_Active_Milcon Army_Act_Milco 299
8 Army_Reserve_Milcon Army_Res_Milco 305
9 Army_NatlGuard_Milcon Army_NG_Milcon 303
10 Army_Family_Housing Army_Family_Ho 308
11 Army_RDT&E Army_RDT&E 295
```

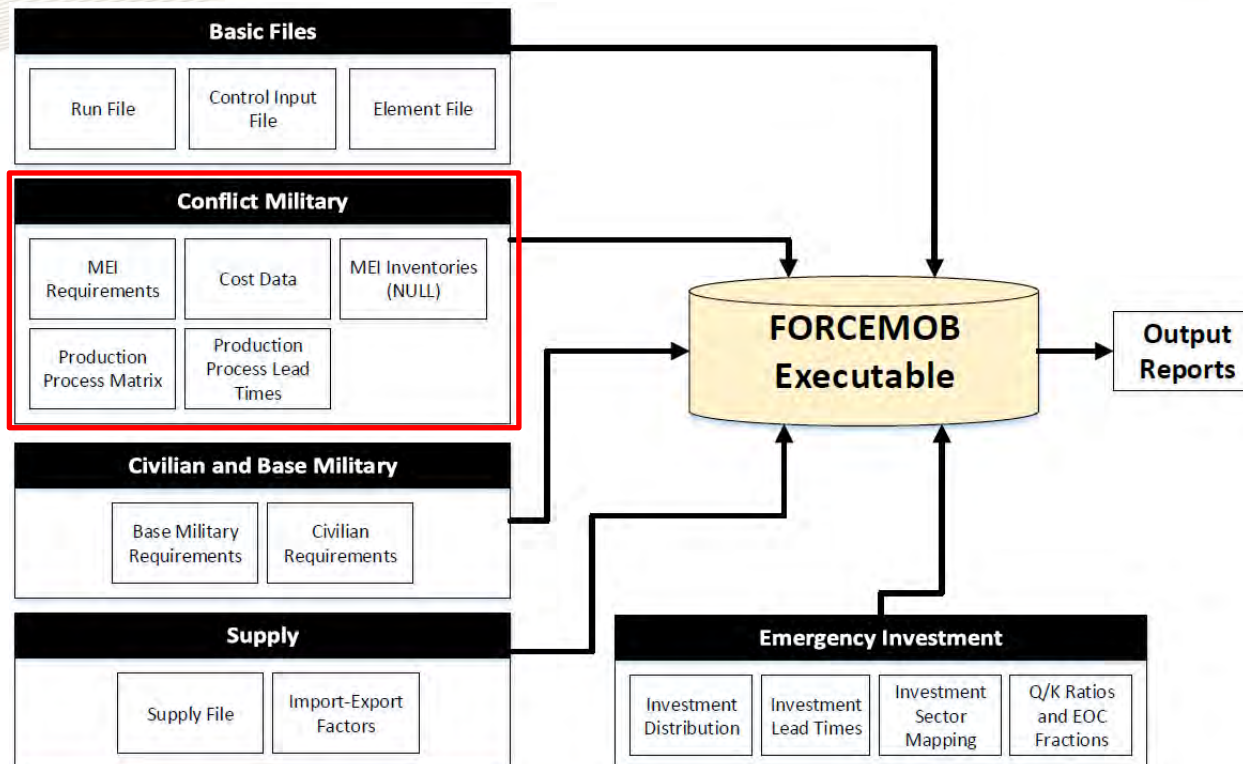
Element File also maps MEIs to METs. Both are unclassified reference numbers for weapons systems, not a listing of specific weapons lost in the (classified) emergency scenario. Other entries in the Element File – “force unit,” “TOE,” “threat item,” “consumption item” – can be ignored.

## IDA | Summary

- The **Control Inputs** file (**.in**) sets many of the basic scenario parameters for a run of FORCEMOB
- The **Run File** (**.inf**) specifies what Control Inputs file to use
- The **Element** file (**element.db**) lists the weapons, economic sectors, constant dollar year, and data range to use



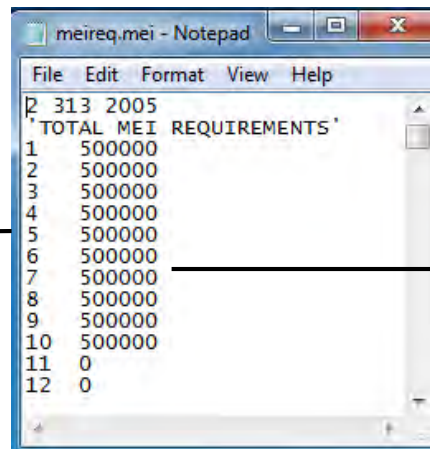
## IDA | Conflict Military Input Files



## IDA | MEI Requirements

- The **MEI Requirements** file (.mei extension) lists weapons systems and quantities thereof lost or expended in the military conflict
- MEIs must be regenerated within three years after the end of the conflict, and hence determine the amount of economic production needed to support “conflict military” requirements
- MEI requirements are classified; the below example is notional and does not correspond to real data

Weapons listed  
by MEI number



File Edit Format View Help	
313	2005
TOTAL MEI REQUIREMENTS	
1	500000
2	500000
3	500000
4	500000
5	500000
6	500000
7	500000
8	500000
9	500000
10	500000
11	0
12	0

How much of each weapon  
(listed in constant \$K, not per-  
unit) must be regenerated



Casualty and expenditure estimates are provided by the Office of the Secretary of Defense, Cost Assessment and Performance Evaluation (OSD-CAPE) on the basis of theater-level combat modeling.

## IDA | Production Process Matrix (PPM)

- The **Production Process Matrix** file (.ppm extension) lists the industrial output required across 360 economic sectors to build a fixed dollar amount of each weapon system
  - For example, how much output from the steel sector and electronics sector are required to produce \$1B worth of tanks?
  - Covers all aspects of production (e.g. tool & die), not just weapon itself
- Used to determine the impact of MEI Requirements on industry

	499	360
1	1	0.1022312E-03
1	2	0.1437477E-03
1	3	0.1691875E-04
1	4	0.2592749E-04
1	5	0.4553045E-04
1	6	0.7005606E-06
1	7	0.7969875E-04
1	8	0.1030473E-04
1	9	0.1825178E-03
1	10	0.1673582E-03
1	11	0.5686470E-04
1	12	0.7711249E-04

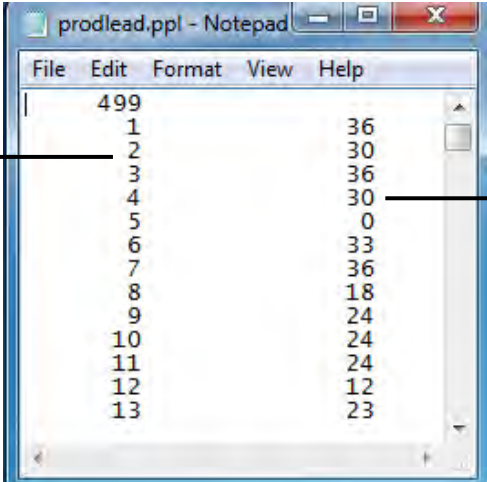
Note that data is organized by Major End Type (MET), not MEI.

METs can be thought of as “bins” into which MEIs can be categorized.

Two MEIs have the same MET if and only if they have the same Defense Translator Vector.

## IDA | Production Process Lead Times

- The **Production Process Lead Times** file (.ppl) specifies the lead times (in months) required to build each weapon system
- This is used in FORCEMOB to time-phase the regeneration of weapons, and hence production requirements thereof



Weapons listed by MET number	Lead time to produce (in months)
499	
1	36
2	30
3	36
4	30
5	0
6	33
7	36
8	18
9	24
10	24
11	24
12	12
13	23

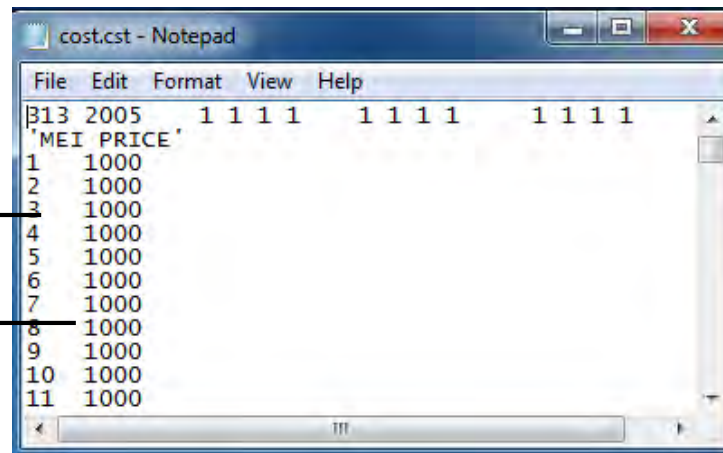
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## IDA | Cost Data

- The **Cost Data** file (.cst extension) lists the cost of every MEI in constant year \$K
- It is used to translate the MEI Requirements into units for output reports
  - MEI Requirements is listed in terms of dollars, and hence must be divided by the cost to determine the number of units
- Actual cost data are sensitive, and so the below figures are notional

Weapons listed  
by MEI number

Cost (constant  
year \$K)

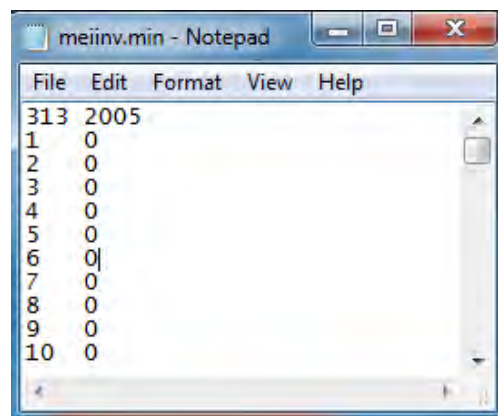


B13 2005 1 1 1 1 1 1 1 1 1 1 1 1											
MEI PRICE											
1	1000										
2	1000										
3	1000										
4	1000										
5	1000										
6	1000										
7	1000										
8	1000										
9	1000										
10	1000										
11	1000										

Cost data is from DOD Comptroller's Green Book and must be in constant year \$K.

## IDA | MEI Inventory File

- The **MEI Inventory** file (.min extension) is a mandatory input, but is not actually used in the method of running FORCEMOB described here
- The user should enter a null file (I.E., with the proper headings but no actual content) as pictured below





MEI inventory relates to an alternate method of running FORCEMOB in which a multi-theater war is assumed to occur, necessitating allocation of regenerated weapons to different theaters. The amount of weapons already in theater therefore would affect the volume and timing of replenishment. This method has largely been deprecated.

## IDA | Summary

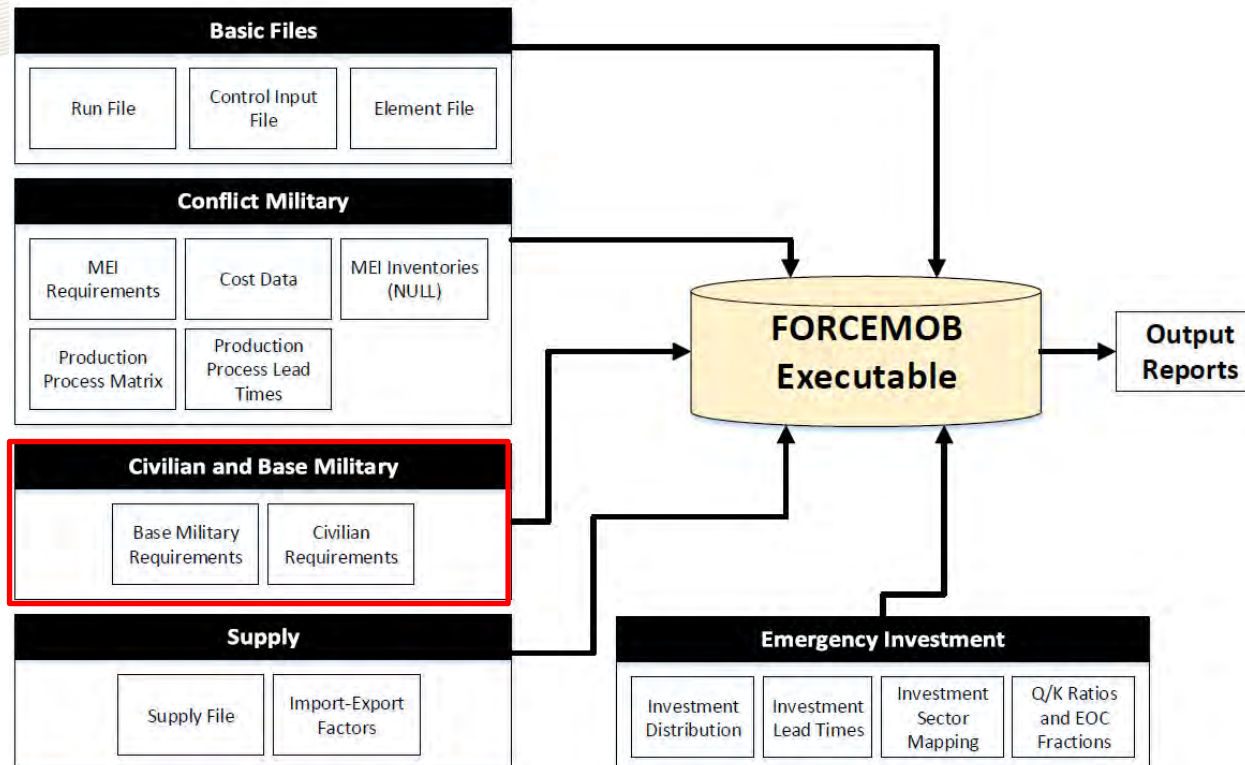
- The **MEI Requirements** file (.mei) lists total dollar (\$K) amounts of weapons to be regenerated
- The **Production Process Matrix** file (.ppm) specifies the demand placed on industry by weapons production
- The **Production Process Lead Times** file (.ppl) lists the time required to build each weapon system
- The **Cost Data** file (.cst) lists the unit cost of each weapon system
- The **MEI Inventories** file (.min) must be entered but is not used

FM reads the  
.mei, .ppm, .ppl,  
.cst, and .min files  
listed in the  
Control Inputs file



FM calculates and  
time-phases  
industrial resources  
required to  
regenerate weapons

## IDA | Civilian Requirements and Base Military Input Files



## IDA | Civilian Requirements

- The **Civilian Requirements** file (.civ) lists the economic output required by the civilian economy (by sector & year)
- Generated using separate modeling tools
  - IDA analysts model the CEA macroeconomic forecast using ILIAD and LIFT, and also incorporate essential civilian demand estimates from the Civilian Advisory Working Group and homeland damage recovery requirements (if modeled) from the DPS and Census Bureau
- The data range is often longer than the simulation period, but only the relevant years are analyzed

Civ reqs per sector, year 1      Civ reqs per sector, year 2      ...and so on

ILIAD sectors

	2009	2023	12	2005	360				
1	11071.46	20189.73	10733.42	9750.35	11403.14	9657.64	9222.96	8268.37	
2	34604.36	24861.84	21548.95	21976.09	22313.83	22399.90	22623.65	22943.38	
3	19909.60	19332.06	19031.59	19941.21	20281.75	20139.63	20315.42	20574.64	
4	26770.39	28042.33	28519.99	29865.73	30141.69	30200.12	30524.91	31054.95	
5	19821.28	21078.58	20187.21	21451.41	21729.31	21801.31	22111.56	22549.71	
6	5991.96	36674.09	22072.95	20344.22	21772.82	18777.97	17316.52	15278.95	
7	1918.12	1878.94	1438.11	1471.02	1578.20	1531.47	1554.49	1560.51	
8	2932.99	3430.29	3097.90	3162.64	3193.19	3220.31	3257.87	3316.54	
9	23167.50	23963.87	19781.60	20223.41	20607.14	21050.57	21451.47	21879.90	
10	81760.49	86314.23	76265.62	77334.95	78237.22	78407.08	78915.01	79887.38	

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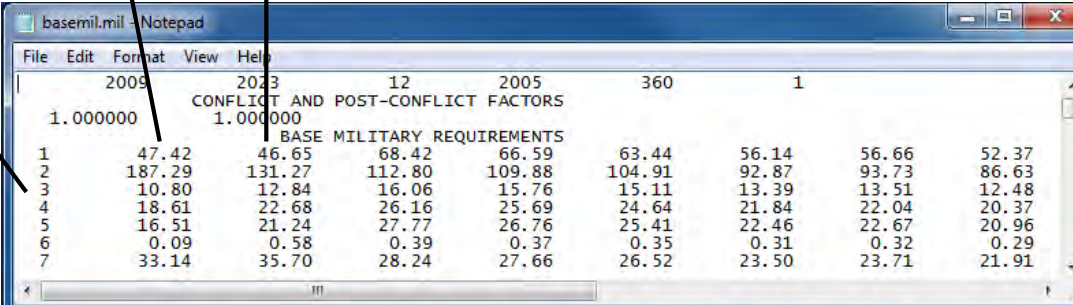
For a full description of how these values are derived using modeling, see D-5432.

## IDA | Base Military Requirements

- The **Base Military Requirements** file (.mil) lists the peacetime economic output required by the military (by sector & year)
- Base military requirements = normal FYDP spending; does not include regeneration of forces lost in military conflict
  - Combined with “Conflict Military” requirements to determine total military requirements
- Also generated using ILIAD and LIFT

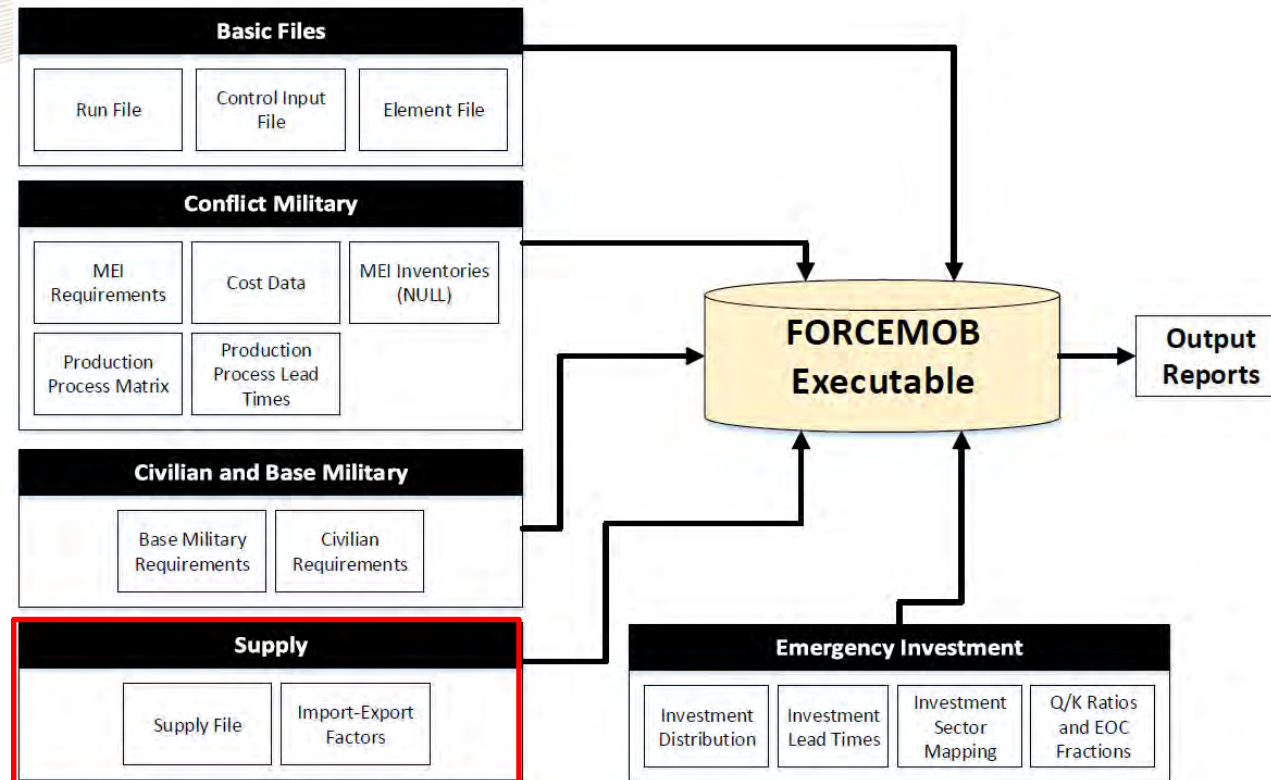
Base mil reqs per sector, year 1      Base mil reqs per sector, year 2      ...and so on

ILIAD sectors



	2009	2013	12	2005	360	1
1.000000	47.42	46.65	68.42	66.59	63.44	56.14
2	187.29	131.27	112.80	109.88	104.91	92.87
3	10.80	12.84	16.06	15.76	15.11	13.39
4	18.61	22.68	26.16	25.69	24.64	21.84
5	16.51	21.24	27.77	26.76	25.41	22.46
6	0.09	0.58	0.39	0.37	0.35	0.31
7	33.14	35.70	28.24	27.66	26.52	23.50

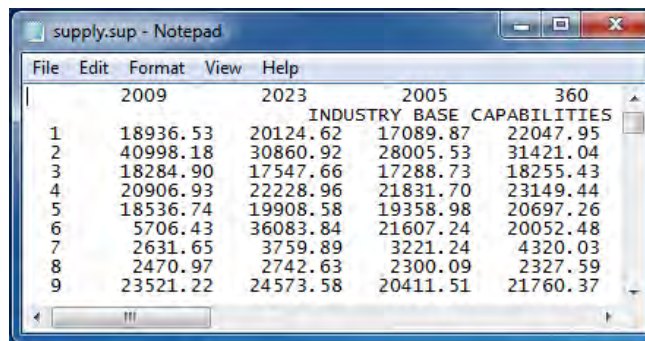
## IDA | Supply Input Files



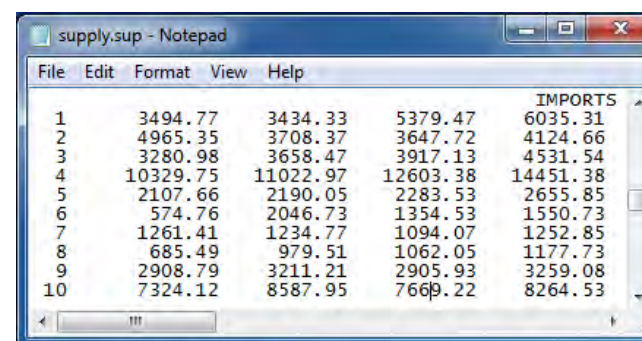


## IDA | Supply File

- The **Supply File** (.sup extension) lists domestic industrial capacities to produce goods and services, plus goods and services imports/exports by year and sector
- Used to compute total industrial supply, determine whether supply (civilian, military, and emergency investment) meets demand, and identify potential economic shortfalls that may be addressed through emergency investment
- Data comes from ILIAD modeling



	2009	2023	2005	360
				INDUSTRY BASE CAPABILITIES
1	18936.53	20124.62	17089.87	22047.95
2	40998.18	30860.92	28005.53	31421.04
3	18284.90	17547.66	17288.73	18255.43
4	20906.93	22228.96	21831.70	23149.44
5	18536.74	19908.58	19358.98	20697.26
6	5706.43	36083.84	21607.24	20052.48
7	2631.65	3759.89	3221.24	4320.03
8	2470.97	2742.63	2300.09	2327.59
9	23521.22	24573.58	20411.51	21760.37



				IMPORTS
1	3494.77	3434.33	5379.47	6035.31
2	4965.35	3708.37	3647.72	4124.66
3	3280.98	3658.47	3917.13	4531.54
4	10329.75	11022.97	12603.38	14451.38
5	2107.66	2190.05	2283.53	2655.85
6	574.76	2046.73	1354.53	1550.73
7	1261.41	1234.77	1094.07	1252.85
8	685.49	979.51	1062.05	1177.73
9	2908.79	3211.21	2905.93	3259.08
10	7324.12	8587.95	7669.22	8264.53



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## IDA | Import-Export Factors

- The **Import-Export Factors** file (.fie) adjusts US imports and exports
- Import adjustments are mostly decrements to account for wartime conditions such as shipping losses or coercive trade disruptions
  - Data is provided to IDA on a *per country* basis, and must be converted to *per industry* before use in FORCEMOB
- This data is classified, and the example file is notional

5% decrement in Year 1      5% decrement in Year 2

ILIAD sectors

	2015	2018
1	0.9500	0.9500
2	0.9500	0.9500
3	0.9500	0.9500
4	0.9500	0.9500
5	0.9500	0.9500
6	0.9500	0.9500
7	0.9500	0.9500
8	0.9500	0.9500
9	0.9500	0.9500
10	0.9500	0.9500

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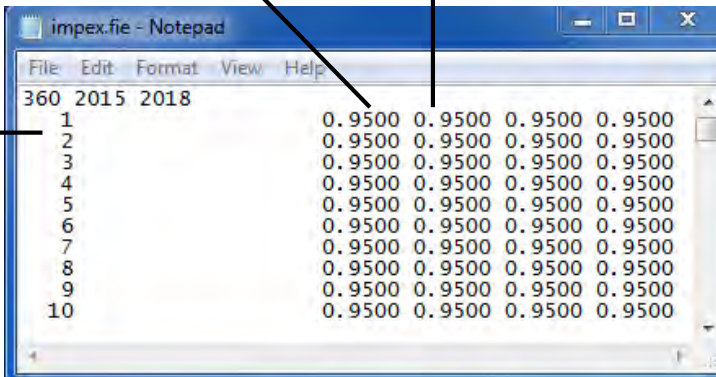
For an example of import adjustment, imagine that Country X exports steel to the US, where it is used in the automobile and aerospace sectors. The DPS specifies Country X has a shipping loss factor of 10%, meaning all trade with it is decremented by that percentage. To be used in FORCEMOB, this adjustment needs to be expressed in terms of its impact on the auto and aerospace sectors. This is done externally and then input to FORCEMOB.

## IDA | Import-Export Factors

- Export adjustments are developed judgmentally on an industry by industry basis
  - The government may choose not to guarantee availability of materials that are used to produce goods for export (in order to preserve materials for critical uses)
  - The government may choose to increase exports in some sectors
- This data is classified, and the example file is notional

5% decrement in Year 1      5% decrement in Year 2

ILIAD sectors

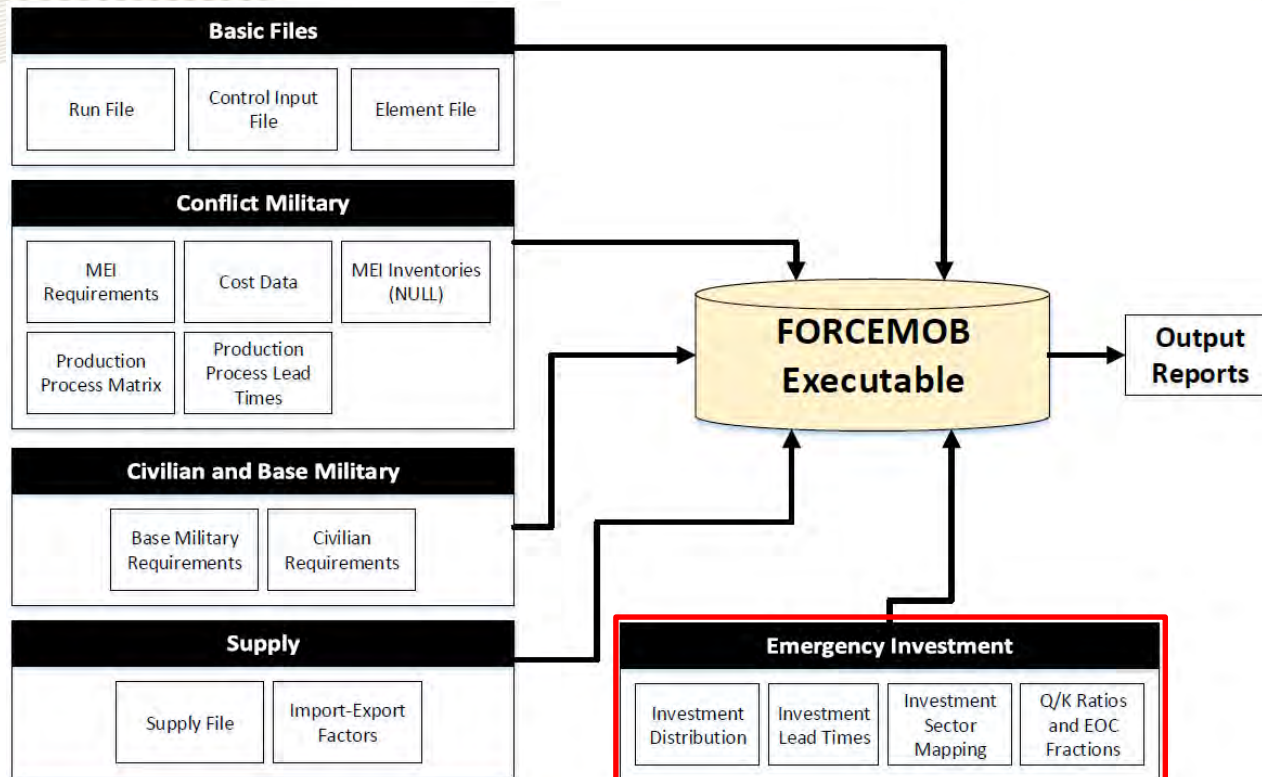


	360	2015	2018				
1				0.9500	0.9500	0.9500	0.9500
2				0.9500	0.9500	0.9500	0.9500
3				0.9500	0.9500	0.9500	0.9500
4				0.9500	0.9500	0.9500	0.9500
5				0.9500	0.9500	0.9500	0.9500
6				0.9500	0.9500	0.9500	0.9500
7				0.9500	0.9500	0.9500	0.9500
8				0.9500	0.9500	0.9500	0.9500
9				0.9500	0.9500	0.9500	0.9500
10				0.9500	0.9500	0.9500	0.9500

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## IDA | Emergency Investment Input Files



## IDA | Investment Distribution

- The **Investment Distribution File (.idr)** specifies the industrial demand generated by emergency investment
  - For example, how much output from the construction and electronics sectors is required to build a new steel factory?
- Uses “investment distribution patterns”
  - For a simplified example, the expansion of productive capacity in grain farming (sector 2) is broadly similar to the expansion of productive capacity in vegetable farming (sector 3) in terms of the demand placed on industry, and so a single investment distribution pattern can be used to model emergency investment in them
  - Allows reduction of problem size: 360 sectors → 67 investment distribution patterns

File	Edit	Format	View	Help
1	1	0.000224		
2	1	0.000301		
3	1	0.000024		
4	1	0.000036		
5	1	0.000179		
6	1	0.000001		
7	1	0.000327		
8	1	0.000012		
9	1	0.000321		
10	1	0.000289		

## IDA Investment Sector Mapping

- The **Investment Sector Mapping** file (.ism) maps economic sectors to investment distribution patterns
  - E.G. grain farming (sector 2) is assigned to the “Farms” investment distribution pattern, while natural gas distribution (sector 29) is assigned to “Utilities”

ILIAD sectors

Investment distribution pattern

ILIAD sectors		Investment distribution pattern
1	Oilseed farming	Farms
2	Grain farming	Farms
3	Vegetable and melon farming	Farms
4	Fruit and nut farming	Farms
5	Greenhouse, nursery, and floriculture production	Farms
6	Tobacco farming	Farms
7	Cotton farming	Farms
8	Sugarcane and sugar beet farming	Farms
9	All other crop farming	Farms
10	Cattle ranching and dairy farming	Farms
11	Poultry and egg production	Farms
12	Animal production, except cattle and poultry and eggs	Farms
13	Forestry and logging	Forestry, fishing, and related activities
14	Fishing, hunting and trapping	Forestry, fishing, and related activities
15	Support activities for agriculture and forestry	Forestry, fishing, and related activities
16	Crude oil extraction	Oil and gas extraction
17	Natural gas extraction	Oil and gas extraction
18	Coal mining	Mining, except oil and gas
19	Iron ore mining	Mining, except oil and gas
20	Copper, nickel, lead, and zinc mining	Mining, except oil and gas
21	Gold, silver, and other metal ore mining	Mining, except oil and gas
22	Stone mining and quarrying	Mining, except oil and gas
23	Sand, gravel, clay, and ceramic and refractory minerals mining	Mining, except oil and gas
24	Other nonmetallic mineral mining and quarrying	Mining, except oil and gas
25	Drilling oil and gas wells	Support activities for mining
26	Support activities for oil and gas operations	Support activities for mining
27	Support activities for other mining	Support activities for mining
28	Electric power generation, transmission, and distribution	Utilities
29	Natural gas distribution	Utilities

## IDA | Investment Lead Times

- The **Investment Lead Times** file (.ilt) specifies the amount of time (in months) needed to build additional productive capacity in an industry
- These values are used to time-phase emergency investment

ILIAD sectors

Time (in months)

ILIAD sectors	Time (in months)	Industry
1	6	oilseed farming
2	6	Grain farming
3	6	Vegetable and melon farming
4	6	Fruit and nut farming
5	6	Greenhouse/nursery/floricult
6	6	Tobacco farming
7	6	Cotton farming
8	6	Sugarcane & sugar beet farming
9	6	All other crop farming
10	6	Cattle ranching & dairy farm
11	6	Poultry and egg production
12	6	Animal prod excl cattle/poult
13	9	Forestry and logging
14	6	Fishing hunting and trapping
15	6	Agriculture & forestry support
16	36	Crude oil extraction
17	36	Natural gas extraction
18	36	Coal mining
19	36	Iron ore mining
20	36	Copper nickel lead zinc mining
21	36	Gold silver & other metal ore
22	12	Stone mining and quarrying



## IDA | Q/K Ratios and EOC Fractions

- The **Q/K Ratios and EOC Fractions File (.qkf)** is a single file containing two separate concepts
- “Q/K Ratio” refers to the amount of output (Q) that could be produced in a month per unit of invested capital (K) in place for a particular economic sector
  - Used to estimate how much additional productive capacity can be generated by emergency investment (e.g., how much extra steel could be produced by a \$100M investment in the steel sector?)

2009	2023	360
2013 output/captial ratios from INFORUM.		
	1	0.106245317
	2	0.106245317
	3	0.106245317
	4	0.106245317
	5	0.106245317
	6	0.106245317
	7	0.106245317
	8	0.106245317
	9	0.106245317
	10	0.106245317

## IDA | Q/K Ratios and EOC Fractions

- “EOC Fractions” refers to emergency operating capacity
  - In peacetime, a factory may only run one 8-hour shift (out of 24 possible hours = 0.33) and only use 75% of its production capacity, and so only utilize 25% ( $0.33 \times 0.75$ ) of its total capacity output
  - This “plant capacity utilization fraction” number is used in FORCEMOB to model the use of spare plant capacity

EOC Fraction, Year 1      EOC Fraction, Year 2

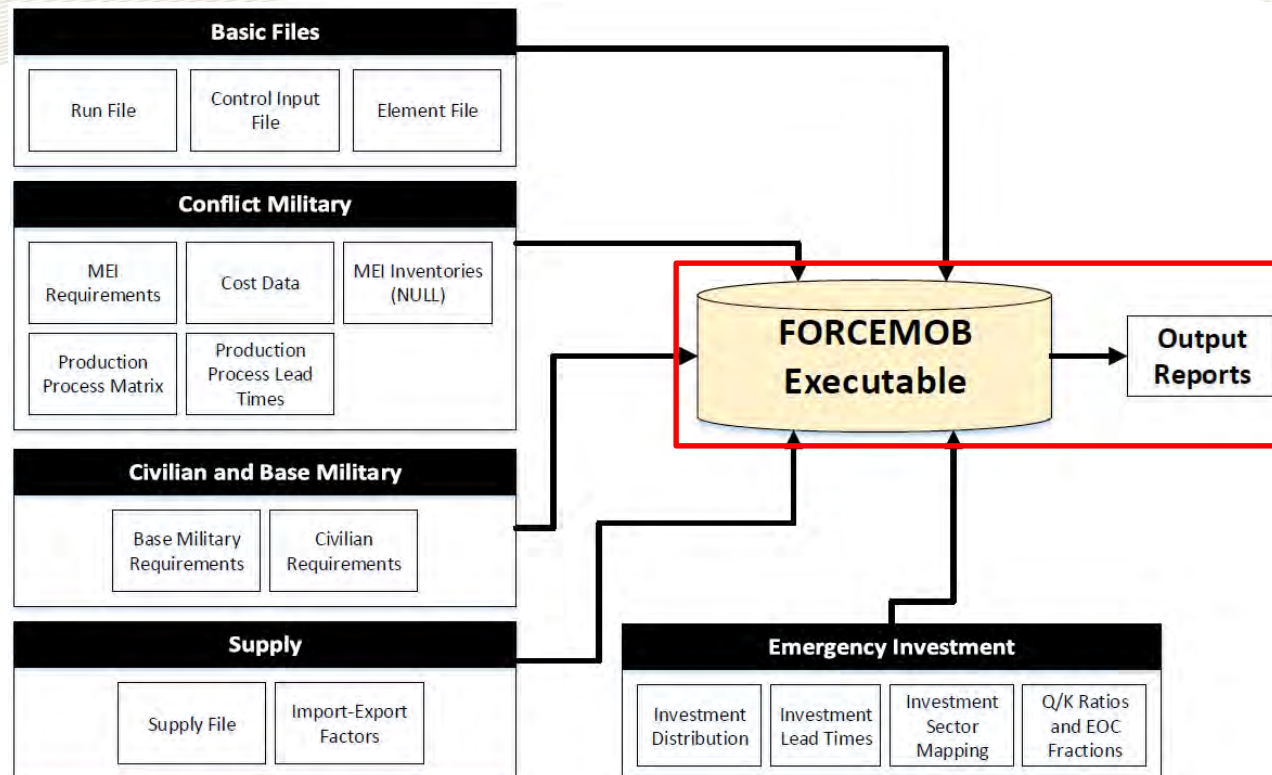
ILIAD sector

eoc fractions below.	2013	EMERGENCY rates from Census	EMERGENCY rates from Census	EMERGENCY rates from Census	EMERGENCY rates from Census
1	0.524832	0.524832	0.524832	0.524832	0.524832
2	0.524832	0.524832	0.524832	0.524832	0.524832
3	0.524832	0.524832	0.524832	0.524832	0.524832
4	0.524832	0.524832	0.524832	0.524832	0.524832
5	0.524832	0.524832	0.524832	0.524832	0.524832
6	0.524832	0.524832	0.524832	0.524832	0.524832
7	0.524832	0.524832	0.524832	0.524832	0.524832
8	0.524832	0.524832	0.524832	0.524832	0.524832
9	0.524832	0.524832	0.524832	0.524832	0.524832
10	0.524832	0.524832	0.524832	0.524832	0.524832

## IDA | Summary

- The **Investment Distribution** file (.idr) lists the demands placed on economic sectors by emergency investment, as codified in investment distribution patterns
- The **Investment Sector Mapping** file (.ism) maps each economic sector to an investment distribution pattern
- The **Investment Lead Times** file (.ilt) lists the amount of time needed to expand production in an economic sector
- The **Q/K Ratios and EOC Fractions** file (.qkf) lists, for each economic sector, the amount of output that could be produced in a month per unit of capital and the plant capacity utilization fraction, respectively
- FORCEMOB uses these values in an algorithm that seeks to determine the emergency investment required to mitigate goods/services production shortfalls in the various sectors of the economy (keeping in mind that investment itself demands industrial resources)
- Overall summary: total U.S. economic production requirements in the emergency scenario are equal to the industrial demand generated by civilian, military (base + conflict), and emergency investment activities, minus imports, and plus exports segregated by year and economic sector

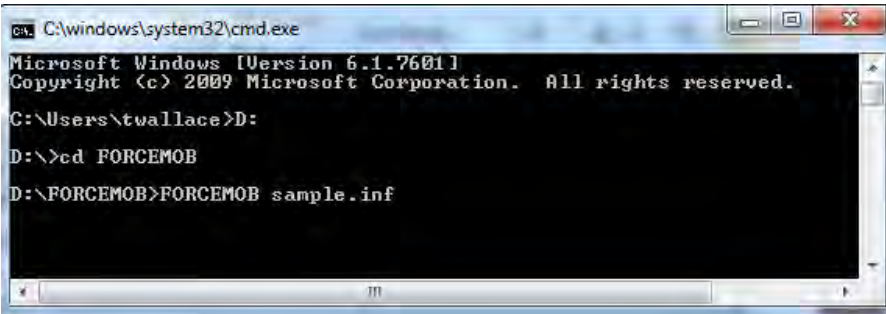
## IDA | Running FORCEMOB and Generating Output



## IDA | Running FORCEMOB

- Once all input files are prepared, the user can run FORCEMOB
- This normally is done from the command line, but the CD associated with this briefing contains a batch file (**start\_me\_up.bat**) that if double-clicked will automatically run FORCEMOB
- The batch file executes FORCEMOB using the Run File (.inf)
- FORCEMOB will run and generate output reports

The batch file, when double-clicked, performs the following operations

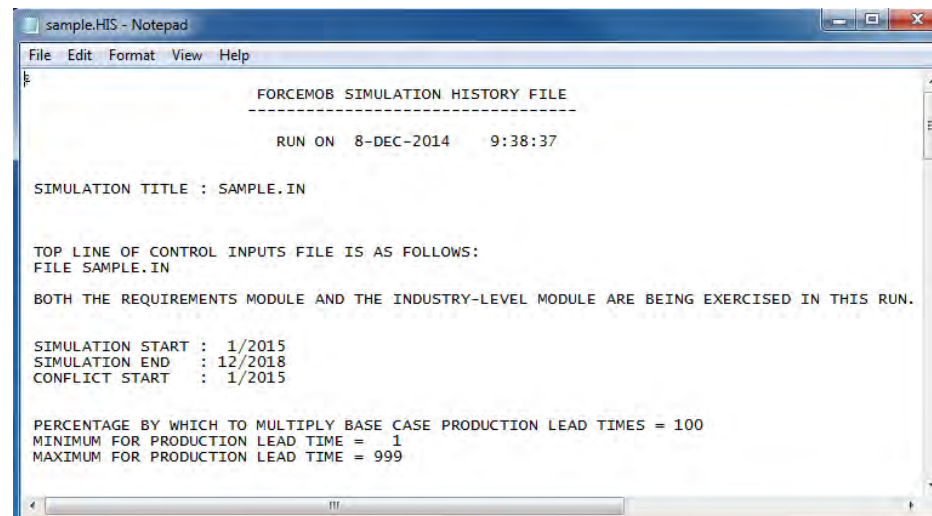


```
C:\windows\system32\cmd.exe
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation. All rights reserved.

C:\Users\twallace>D:
D:\>cd FORCEMOB
D:\FORCEMOB>FORCEMOB sample.inf
```

## IDA | Automatic Output Reports

- Although the user has some control over what output reports FORCEMOB generates, some output reports are automatically generated
- The most important is the **History** file (**.his** or **.hsc**), which logs the assumptions and operations of a particular FORCEMOB run
- This is a valuable resource for post-run analysis and debugging



The screenshot shows a Notepad window titled 'sample.HIS - Notepad'. The text inside the window is as follows:

```

                                FORCEMOB SIMULATION HISTORY FILE
                                -----
                                RUN ON  8-DEC-2014    9:38:37

SIMULATION TITLE : SAMPLE.IN

TOP LINE OF CONTROL INPUTS FILE IS AS FOLLOWS:
FILE SAMPLE.IN

BOTH THE REQUIREMENTS MODULE AND THE INDUSTRY-LEVEL MODULE ARE BEING EXERCISED IN THIS RUN.

SIMULATION START : 1/2015
SIMULATION END   : 12/2018
CONFLICT START  : 1/2015

PERCENTAGE BY WHICH TO MULTIPLY BASE CASE PRODUCTION LEAD TIMES = 100
MINIMUM FOR PRODUCTION LEAD TIME = 1
MAXIMUM FOR PRODUCTION LEAD TIME = 999

```

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## IDA | Selected Output Reports

- FORCEMOB also generates output reports selected by the user in the Control Inputs file
- FORCEMOB can generate over 40 different reports, so typically only a subset is used
- The training version of FORCEMOB associated with this document is set up to only generate the two most important files, the **.ppf** and **.pfc** reports
- Both files are used to compute material demand later in RAMF-SM, and should be regarded as the main output of FORCEMOB
- They differ only in formatting: .pfc is comma-delimited, .ppf is not

## IDA | Selected Output Reports

sample.PFC - Notepad

File Edit Format View Help

CIVILIAN OUTPUT REQUIREMENTS

1,oilseed farming	9222.960,	8268.370,	8425.030,	9748.580,
2,Grain farming	22623.650,	22943.381,	23361.980,	23744.920,
3,vegetable and melon farming	20315.420,	20574.641,	21002.070,	21472.039,
4,Fruit and nut farming	30524.910,	31054.949,	31673.480,	32196.410,
5,Greenhouse/nursery/floricult	22111.561,	22549.711,	23061.859,	23497.789,
6,Tobacco farming	17316.520,	15278.950,	14492.820,	15129.140,
7,cotton farming	1554.490,	1560.510,	1623.610,	1729.020,
8,Sugarcane & sugar beet farming,	3257.870,	3316.540,	3378.640,	3427.690,
9,All other crop farming	21451.471,	21879.900,	22305.971,	22605.260,
10,cattle ranching & dairy farm	78915.008,	79887.383,	81025.273,	81828.523,

sample.PFC - Notepad

File Edit Format View Help

TOTAL MILITARY OUTPUT REQUIREMENTS

1,oilseed farming	57.380,	52.370,	51.610,	51.330,
2,Grain farming	95.095,	86.630,	85.370,	84.890,
3,vegetable and melon farming	14.104,	12.480,	12.300,	12.230,
4,Fruit and nut farming	22.584,	20.370,	20.060,	19.950,
5,Greenhouse/nursery/floricult	24.146,	20.960,	20.660,	20.550,
6,Tobacco farming	0.532,	0.290,	0.290,	0.290,
7,cotton farming	24.001,	21.910,	21.590,	21.460,
8,Sugarcane & sugar beet farming,	8.221,	7.480,	7.370,	7.330,
9,All other crop farming	134.097,	121.870,	120.140,	119.490,
10,cattle ranching & dairy farm	210.190,	188.590,	185.770,	184.670,

sample.PFC - Notepad

File Edit Format View Help

INVESTMENT OUTPUT REQUIREMENTS

1,oilseed farming	0.000,	0.000,	0.000,	0.000,
2,Grain farming	0.000,	0.000,	0.000,	0.000,
3,vegetable and melon farming	0.000,	0.000,	0.000,	0.000,
4,Fruit and nut farming	0.000,	0.000,	0.000,	0.000,
5,Greenhouse/nursery/floricult	0.000,	0.000,	0.000,	0.000,
6,Tobacco farming	0.000,	0.000,	0.000,	0.000,
7,cotton farming	0.000,	0.000,	0.000,	0.000,
8,Sugarcane & sugar beet farming,	0.000,	0.000,	0.000,	0.000,
9,All other crop farming	0.000,	0.000,	0.000,	0.000,
10,cattle ranching & dairy farm	0.000,	0.000,	0.000,	0.000,



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# Practice Problems

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## **IDA | Practice Problem #1**

- The following questions refer to the FORCEMOB files located on the CD associated with this briefing, and are intended to test the reader's ability to locate critical information
  - What is the start date of the conflict?
  - What MEIs must be regenerated?
  - What is the dollar reference year?
  - What Case File is being used?
  
- Answers are in the notes section of this slide

The start date is 1/2015. This information can be found in the Control Inputs (.in) file.

The MEIs to regenerate are 500000 (\$K) each of 1,2,3,4,5,6,7,8,9, and 10. This information can be found in the MEI Requirements (.mei) file.

The dollar reference year is 2005. This information can be found in the Element (element.db) file.

The Case File being used is sample.in. The Run file (.inf) lists the Case File that FORCEMOB will use.

## **IDA | Practice Problem #2**

- Using the files provided, what are total military requirements in year 3 of the scenario?
- Answer is in the notes section of this slide

Answer: 967479.875

This information can be found in the output reports.

## **IDA | Practice Problem #3**

- Suppose the user wishes to analyze an alternate case in which the U.S. suffers unexpectedly heavy casualties (50% more than Base Case)
  1. Which input files would the user modify, and how?
  2. How would FORCEMOB output change?



- The user would need to modify three input files. First, the user would create a new MEI Requirements file that increases requirements by 50% for each weapon. Let us call this file “ALTmei.mei.” Second, the user would create a new Control Inputs file specifying that FORCEMOB should use the new MEI Requirements file, ALTmei.mei, rather than the “normal” MEI Requirements file. Let us call the new Control Inputs file “ALTsample.in.” Third, the user would create a new Run file to tell FORCEMOB to use the new Control Inputs file, ALTsample.in, rather than the normal Control Inputs file. The user then would run FORCEMOB.
- Conflict military requirements would rise.

## Appendix A

### Abbreviations

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CAPE	Cost Assessment and Performance Evaluation
CD	Compact disc
CEA	Council of Economic Advisers
DLA	Defense Logistics Agency
DPS	Defense Planning Scenarios
FORCEMOB	Forces Mobilization Model
FYDP	Future Years Defense Program
IDA	Institute for Defense Analyses
ILIAD	Interindustry Large-scale Integrated and Dynamic model
INFORUM	Interindustry Forecasting Project at the University of Maryland
I/O	Input output
LIFT	Long-term Interindustry Forecasting Tool
MEI	Major End Item
MET	Major Equipment Type
NDS	National Defense Stockpile
NDS-RR	National Defense Stockpile Requirements Report
OSD	Office of the Secretary of Defense
PPM	Production Process Matrix
RAMF-SM	Risk Assessment and Mitigation Framework for Strategic Materials
S&CMs	Strategic and critical materials
SSM	Stockpile Sizing Module
US	United States

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